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Improving prescribing practices: A pharmacist-led educational intervention for nurse practitioner students

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Abstract

Background and purpose: To assess impact of a pharmacist-led educational intervention on family nurse practitioner (FNP) students' prescribing skills, perception of preparedness to prescribe, and perception of pharmacist as collaborator.

Method: Prospective pre–post assessment of a 14-week educational intervention in an FNP program in the spring semester of 2014. Students participated in an online module of weekly patient cases and prescriptions emphasizing legal requirements, prescription accuracy, and appropriate therapy. A pharmacist facilitator provided formative feedback on students' submissions. Participants completed a matched assessment on prescription writing before and after the module, and a retrospective postsurvey then presurvey to collect perceptions.

Conclusion: There was significant improvement in performance on error identification and demonstration of prescription elements from preassessment to postassessment (+17%, $p < .001$). The mean performance on both assessments was less than the 70% passing score. Students reported significant positive changes in perceptions, including all statements regarding their preparedness to prescribe and those addressing willingness to collaborate with pharmacists.

Implications for practice: Formative education on prescribing enhanced students' understanding of safe and effective medication use with improved recognition and avoidance of prescribing errors, although it did not result in competency. Exposure to pharmacist expertise in this area may encourage collaboration in practice.

Introduction

Like physicians, nurse practitioners have prescriptive authority within the scope of their practice (Newhouse et al., 2011). In the 2009–2010 American Association of Nurse Practitioners Sample Survey of 13,562 nurse practitioners, 97.6% reported prescribing medications to patients, averaging 22 prescriptions per day in full-time practice (Goolsby, 2011). However, studies have shown that new prescribers often do not feel adequately prepared (Hilmer, Seale, Le Couteur, Crampton, & Liddle, 2009; Rauniar, Roy, Das, Bhandari, & Bhattacharya, 2008). Evaluation of errors in various settings has determined

that most preventable adverse drug events occur as the result of errors made in the prescribing stage (Thomsen, Winterstein, Søndergaard, Haugbølle, & Melander, 2007). A study by Kuo, Phillips, Graham, and Hickner (2008) reported that 70% of errors made in primary care physicians' offices were prescribing errors. Medication selection and dose were the most common types of prescribing error, with the most error-prone factors being incorrect drug selection, contraindications such as medication allergies, incorrect dosing, and including insufficient information on the prescription. In the study, pharmacists were responsible for preventing the errors from reaching patients the majority of the time, consistent with their training and expertise. However, pharmacists may not be routinely utilized to their potential by nurse practitioners. In the Nurse Practitioner Sample Survey, the reported frequency of pharmacist consultation by nurse practitioners was weekly (30.3%), monthly (29.9%), one to two times per year (29.7%), daily (6.9%), and never (3.2%, Goolsby, 2011). Yet incorporation of pharmacists into the patient care team has been identified as a healthcare strategy with positive outcomes for patients, including improvement in clinical markers such as hemoglobin A1c, LDL cholesterol, and blood pressure and reduction in adverse drug events (Chisholm-Burns et al., 2010).

This is the first study to assess the impact of a pharmacist educating nurse practitioner students on the elements of appropriate, safe, and complete prescription writing with weekly online patient cases. We hypothesized that the incorporation of a pharmacist in nurse practitioner student learning could improve preparedness to prescribe as well as encourage collaboration with pharmacists as part of an interprofessional healthcare team. The purpose of this study was to evaluate an existing educational intervention in the family nurse practitioner (FNP) curriculum to assess the impact on: (a) students' clinical and procedural accuracy of prescribing, (b) students' perception of preparedness to prescribe, and (c) students' perception of a pharmacist as a collaborator.

Methods

This study was a prospective pre–post assessment of a 14-week educational intervention designed to improve technical and clinical aspects of prescribing of FNP students. This research was determined to be exempt by The Ohio State University Institutional Review Board.

Educational intervention

In an effort to expand interprofessional learning beyond experiential educational settings, our faculty–practitioner team developed and implemented a pharmacist-directed prescribing intervention, delivered as a 14-week online education module for FNP students. The intention of the program was for a clinical pharmacist to educate students at The Ohio State University (Ohio State) and provide them longitudinal practice for appropriate prescribing habits, including the identification and correction of the factors commonly associated with prescribing errors. The technical aspect of appropriate prescribing requires the provider to include all necessary elements for a legally complete and accurate prescription. Clinical prescribing errors have a greater potential to cause patient harm and involve medication choice and dosing with respect to indication as well as patient specific factors including concurrent medications or comorbidities (Velo & Minuz, 2009).

FNP students enrolled in a clinical practicum during spring semester 2014 participated in an online module delivered using the course management platform at Ohio State (Carmen; www.carmen@osu.edu). Each week, the pharmacist facilitator posted a patient case to the discussion board and students were asked to review a corresponding prescription for accuracy and appropriateness or to generate a prescription for the patient. The weekly exercises emphasized legal requirements and accuracy (technical elements) as well as patient safety considerations (clinical elements). A summary of the various clinical prescribing issues addressed in the weekly exercises is provided in Table 1. Students were asked to identify any errors in the prescription, provide three patient counseling points for the medication prescribed, and then demonstrate a correct prescription for the patient. Each week, the pharmacist posted a response that provided formative feedback on errors commonly identified and/or missed by the students, addressed any misconceptions from the class, and answered additional questions that had been raised by the class. The exercises were graded as satisfactory/unsatisfactory based on student participation.

Assessments

Prescribing skills before and after the didactic intervention were assessed using an original assessment tool, developed with input from Ohio State's University Center for Advancement of Teaching (a campus-wide teaching center). The assessment was reviewed for face validity and content validity by the investigator team and the collaborating educational consultants, respectively. Students were given limited time (20 min) to complete each assessment in order to simulate the limited decision-making and prescribing time that is available in practice. Research assessments were administered at predetermined times during the study protocol, specifically before and after the 14-week online educational intervention. All students

Table 1 Description of clinical prescribing issues addressed in intervention

Case number	Clinical issues addressed
1	Prescribing a medication without a clinical indication
	Medication allergy to prescribed agent
	Medication dosed incorrectly
	Quantity prescribed does not cover duration of treatment
	Drug–drug interaction
2	Topical formulation prescribed when oral formulation indicated
	Ambiguous directions contributing to inaccurate dosing
	Refills inappropriate as patient should be reevaluated
3	Drug–disease state interaction
	Maximum safe daily dose exceeded
4	Drug–age interaction
	Drug–disease state interaction
	Alternative drug choice more appropriate based on patient-specific factors
5	Inappropriate dosage form for pediatric patient
	Dose inaccurate based on patient weight
	Refills inappropriate as patient should be reevaluated
6	Additional medication not indicated based on therapeutic goals
	Maximize current therapy before adding additional agent
	Alternative drug choice more appropriate based on patient-specific factors
	Dose too high
7	Drug contraindicated in pregnant patient
	Refills inappropriate as patient should be reevaluated
	Stepwise dose increase more appropriate
8	Drug–disease state interaction
	Maximize current therapy before adding additional agent
	Stepwise dose increase more appropriate
9	Ambiguous directions contributing to inaccurate dosing
	Dose inaccurate based on patient weight
10	Dosing of medication inappropriate due to narrow therapeutic index
11	Patient requires additional work up before prescribing
12	Medication allergy to prescribed agent
13	Prescribing medication without accompanying prescription for supplies
	Alternative drug choice more appropriate based on guidelines
	Drug choice and cost considerations
	Ambiguous directions making accurate dosing challenging

were required to complete the assessments as part of the course requirements, but only those consenting to the research had their responses included in the study. All students enrolled in the course were eligible to participate in the study.

The preassessment consisted of questions regarding four prescription cases and a demographic survey. Cases 1–3 asked the students to identify any clinical or technical errors in the corresponding prescriptions. Case 4 prompted the students to write a prescription on the prescription blank provided. Demographic questions targeted baseline characteristics of participants: age, gender, primary language, prior exposure to pharmacists or pharmacy students, and the number of prescriptions written prior to the activity.

The postassessment included the identical prescription cases and a retrospective postsurvey then presurvey, which was used to collect information on the students' perceived preparedness to prescribe, willingness to collaborate with pharmacists, and perception of the pharmacist as the educator. The retrospective postsurvey then presurvey differs from the more common presurvey then postsurvey design in that respondents complete both surveys at the conclusion of the intervention. This is done to address the fact that respondents who have little experience with a subject prior to an educational intervention are unable to accurately assess their perceptions of the subject on a presurvey (Rockwell & Kohn, 1989). This tool was chosen to allow the students to self-report their perceived change over time using the same scale for pre- and postresponses and without the potential bias introduced by a traditional pretest. The 11 perception questions or statements were rated on a 4-point Likert scale ranging from "strongly disagree" to "strongly agree" and from "highly unlikely" to "highly likely," as appropriate. In answering the postsurvey then presurvey, students were asked to provide a response to each question or statement first with what their perceptions were at the point of conclusion of the educational intervention and then think back to the point prior to starting the educational intervention.

Data analysis

Errors to be identified in the assessment were grouped by type (i.e., technical or clinical), level of impact (i.e., patient harm, inconvenience, or minimal impact), and category of error (i.e., directions, dosing, patient elements, medication elements, etc.). Four practitioner investigators individually assigned the groupings of each error and then met to achieve consensus on the final groupings prior to administration of the preassessment. The prescription assessment was scored for each student as the percentage of errors correctly identified/avoided, both overall and within each specific category of errors. Competency was assessed by comparing the overall score to 70%, a standard passing score for a graduate nursing program. Improvement from preassessment to postassessment was measured as the increase in percentage correct for each category. Preassessment, postassessment, and change scores are reported as median with interquartile range (first quartile to third quartile) across the 26 students. Nonparametric Wilcoxon

sign rank tests were applied to the change scores to assess within-student improvement overall and within error type, severity of impact, and category using SAS 9.3 (Cary, NC). For the retrospective postsurvey then presurvey, responses were reported as frequency and percentage. The primary questions measuring student perceptions by signed rank test were assessed with the null hypothesis being zero change. No adjustments were made for multiple comparisons.

Results

All of the 30 FNP students enrolled in the course consented for the study. Of those, two students were ineligible due to nonattendance at the administration of the preassessment and two more students withdrew from the course before the postassessment was administered, resulting in a final participant pool of 26. The majority of participants were female, aged 25–30, spoke English as a primary language, and were registered nurses. Work experience was the most common exposure to pharmacists or pharmacy students (Table 2).

Prescribing ability

The overall performance on the prescription cases from the preassessment to postassessment showed improvement with a median increase of 17% ($p < .001$); the overall median score for the postassessment was 57% (Table 3). Identification of errors and demonstration of clinical and technical prescription elements from preassessment to postassessment also improved ($p < .001$). Individually, two of 26 students (8%) had an overall score greater than 70% on the postassessment, compared to zero students on the preassessment.

The performance on technical elements was consistently greater than the performance on clinical elements, with legal requirements of controlled substance prescribing showing the least improvement from preassessment to postassessment. When errors to be identified were grouped by potential patient impact, the improvement was significant from preassessment to postassessment across all three levels of potential impact: harm ($p < .001$), inconvenience ($p < .001$), and minimal impact ($p = .01$). Improvement from preassessment to postassessment on categories of errors was significant for those pertaining to directions, dosing, patient elements, prescriber elements, medication elements, and other required elements (see Table 3). Only the change in performance from preassessment to postassessment on error-prone abbreviations was not significant ($p = .17$).

Table 2 Demographic characteristics of 26 family nurse practitioner students[a]

	N (%)
Age	
<24 years	3 (12)
25–30 years	13 (50)
31–35 years	6 (23)
>35 years	4 (15)
Gender	
Female	22 (85)
Primary language	
English	25 (96)
Other	1 (4)
Credentials earned	
RN	20 (77)
BSN	13 (50)
Other	1 (4)
Exposure to pharmacists or pharmacy students	
Work experience	13 (50)
Part of a required course	10 (38)
Experiential rotations	7 (27)
Part of an elective course	4 (15)
Volunteer experience	3 (12)
No previous exposure	2 (8)
Student organization	2
Family member or close friend who is a pharmacist	
Yes	9 (35)
Number of prescriptions written	
<10 prescriptions	1 (4)
11–50 prescriptions	8 (31)
51–100 prescriptions	12 (46)
>100 prescriptions	5 (19)

[a]The Ohio State University, 2014.

Perceptions

On the retrospective postsurvey then presurvey, the students reported statistically significant increases in the perception ratings on all statements that addressed their preparedness to prescribe. Following the educational intervention, there was an increase in agreement that classroom education and clinical rotations prepared the students for prescribing ($p = .03$ and $p = .04$, respectively) and that nurse practitioners should have formal training on writing prescriptions ($p = .03$). The largest positive change was seen in response to the statement, "I feel completely prepared to prescribe medications" ($p < .001$). Students who reported having written fewer prescriptions prior to the online prescribing module showed a significantly larger positive change from preassessment to postassessment in response to the statement, "I feel completely prepared to prescribe medications" ($p = .01$).

A similar trend was seen on all statements that addressed the pharmacist as the educator, as students agreed that a pharmacist-led prescribing activity is helpful in

Table 3 Family nurse practitioner student performance[a] on assessments[b]

Median (IQR)	Preassessment	Postassessment	Change[c]	*p*-Value
Overall	38% (30–47%)	57% (49–66%)	17% (11–23%)	<.001
Type of error				
Clinical	27% (18–36%)	45% (36–55%)	16% (5–23%)	<.001
Technical	44% (36–60%)	68% (60–76%)	20% (12–28%)	<.001
Patient impact				
Harm	30% (22–39%)	48% (35–57%)	15% (4–26%)	<.001
Inconvenience	50% (39–67%)	72% (67–78%)	25% (11–33%)	<.001
Minimal impact	33% (17–50%)	50% (33–83%)	17% (0–33%)	.01
Category of error				
Directions	19% (13–38%)	44% (25–50%)	19% (0–38%)	.003
Dosing	25% (0–50%)	50% (25–50%)	25% (0–50%)	.02
Error-prone abbreviations	25% (0–25%)	25% (0–50%)	0% (0–25%)	.17
Patient elements	80% (60–100%)	100% (80–100%)	10% (0–40%)	.004
Prescriber elements	40% (40–60%)	80% (80–100%)	40% (20–60%)	<.001
Medication elements	50% (38–63%)	63% (63–75%)	13% (13–25%)	<.001
Other required elements	33% (17–50%)	67% (50–83%)	17% (0–50%)	<.001

[a]Performance measured as percentage of possible errors identified for each category and reported as median and interquartile range (IQR: first and third quartiles) across all 26 students.
[b]The Ohio State University, 2014.
[c]Change reported as median of individual differences calculated from preassessment to postassessment for each of 26 students.

preparing nurse practitioners to prescribe ($p = .01$) and that pharmacists are qualified to educate nurse practitioners on prescribing ($p = .03$). Significant positive changes in perception were also demonstrated on three out of five statements that addressed their willingness to collaborate with a pharmacist in practice (Figure 1).

Discussion

In our study, a pharmacist-led educational intervention resulted in significant improvement in prescribing abilities for FNP students, almost entirely across the spectrum of abilities assessed. The prescription cases in the assessment highlighted examples of factors most commonly associated with prescribing errors, including dosing and other medication elements. Students demonstrated significant improvement in their ability to identify/avoid these errors, suggesting that instruction in both the technical and clinical components of prescribing supported appropriate and safe prescription writing. In particular, there was significant improvement in identification and avoidance of errors that were categorized as having potential for patient

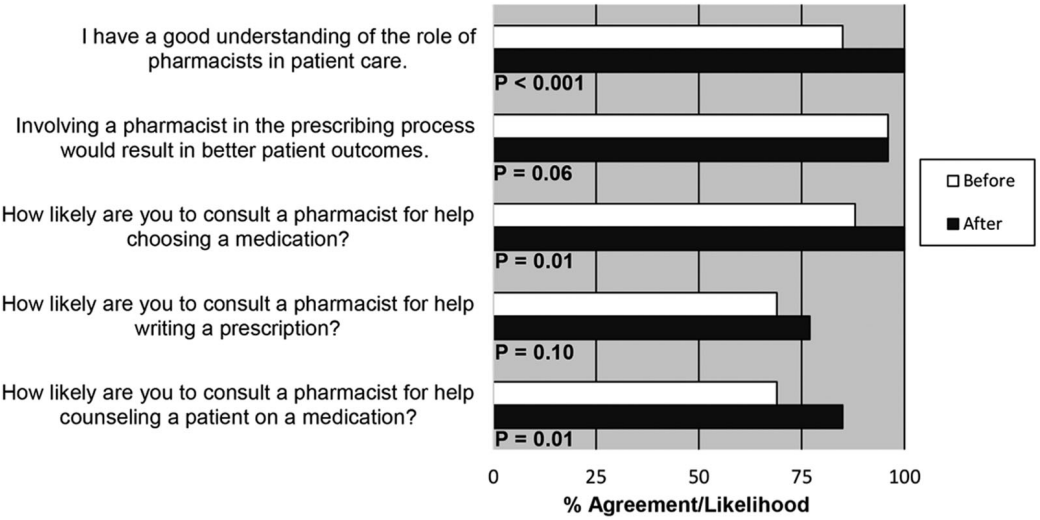

Figure 1 Family nurse practitioner student perceptions regarding collaboration with pharmacist in practices.

harm. In general, improvements on items related to technical proficiency were greater than those related to clinical performance, with the exception being the legal requirements of controlled substance prescribing which remained very low on both assessments.

Unfortunately, the overall postassessment average remained below the standard passing score for a graduate nursing program, and a >30% error rate would be far from acceptable in patient care. This suggests that longitudinal, online learning activities are effective in improving prescribing abilities; however this single module was not sufficient in itself. Our results are consistent with findings of a published systematic review that examined the impact of various therapeutic tutorials and workshops on new practitioner knowledge and prescribing skill (Kamarudin, Penm, Chaar, & Moles, 2013). In the included studies, a range of interventions were studied with many showing improvements in prescribing performance, including those incorporated into structured academic curricula. However, subjects were most commonly medical interns and the intervention was typically a single session without the opportunity for prescribing practice or formative feedback. The study in the review most similar to our research utilized an 8-week intervention for medical students comprised of four 1-h physician and pharmacist-led tutorials and eight 1-h practical sessions on prescribing (Sandilands et al., 2011). Students were given a pretest and posttest to assess incidence of prescribing errors and self-reported confidence. Those investigators demonstrated improved performance and confidence, but also with continued prescribing errors made on the posttest and overall mean posttest performance ≤70%.

To build upon previously studied interventions, we designed our online prescribing module to provide both longer-term (longitudinal) practice and formative feedback on prescribing. Students specifically had regular practice with repeated exposure to technical elements of prescription writing (which showed the greatest improvements), while each clinical element was addressed only a maximum of three times over 14 weeks (Table 1). The importance of practice as a research-based learning strategy is well-known. In the book *How Learning Works: 7 Research Based Principles for Smart Teaching*, authors note that both sufficient quantity of practice and practice over time (*accumulating practice*) are needed (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010, pp. 133–136). Typically, instructors and students alike underestimate how much practice is needed. Therefore, additional cases focused on clinical components related to patient factors, errors with potential for patient harm, error-prone abbreviations, and legal requirements of controlled substance prescribing would likely have benefited the study participants, and may have resulted in greater change. A strategy for continuing the online exercises throughout the FNP didactic curriculum could be explored and studied further.

The retrospective postsurvey then presurvey examined the impact of the intervention as perceived by the students, with the greatest significant increase in perception rating from preassessment to postassessment on the statement, "I feel completely prepared to prescribe." After completion of the educational intervention, 81% of students agreed that they were completely prepared to prescribe medications, compared to only 27% of students who agreed with the statement prior to completion of the educational intervention. Those students who had written fewer prescriptions prior to the intervention showed a significantly larger positive change on the survey statement regarding feeling completely prepared to prescribe. Though the general perception of preparedness is not consistent with our objective results, an expected benefit of targeted feedback is to help students more accurately discern change in learning behaviors and assess their own progress. The "nonpassing" postassessment scores may suggest that students did not review all of the posted feedback from the weekly exercises. Online posting of the feedback with student-directed review cuts down on the time investment required from the pharmacist facilitator and allows for broader application with limited resources. Kamarudin et al. suggest that prescriber feedback in the form of "provider letters" is a cost-effective teaching strategy (Kamarudin et al., 2013), but the heavy reliance on student independence and student inexperience may have limited the learning gains in our format.

Despite the poor prescribing performance on the preassessment, students ranked highly their previous instruction for prescribing (i.e., prescribing activities in previous classes and during clinical rotations, provided before this educational intervention). This was unexpected, as we believed students would recognize that they were not highly prepared at the time of the preassessment. However, students were never given the results of, or solutions to, the preassessments in an effort to prevent recall bias. Therefore, the students did not seem to clearly differentiate between the respective impact of the studied educational module versus prior classroom education and clinical rotations. Module enhancements such as providing the students with the objective scores on the preassessments and postassessments, conducting formal review sessions, and/or having the weekly feedback being facilitated as asynchronous online discussions should be considered to encourage students to rework cases, consider alternatives, and self-assess.

Ninety-six percent of students agreed with the statement, "Involving a pharmacist in the prescribing process would result in better patient outcomes" with no change from the preassessment to postassessment ratings.

Although the students also strongly agreed that pharmacists should be involved in prescribing, there was actually the least change in perception on the statement, "How likely are you to consult a pharmacist for help writing a prescription?" (69% on the preassessment vs. 77% on the postassessment). Though positive, this trend was not found to be significant. A possible explanation for this is that the students may not have anticipated requiring help writing a prescription after the educational intervention (i.e., expecting they were now proficient). Perceptions regarding collaboration with a pharmacist in practice prior to the educational intervention may have been confounded by consistent promotion of interprofessional collaboration by nurse practitioner educators within the curriculum.

Though the tools utilized were not validated, a major strength of the study is that the assessments were designed and implemented collaboratively between pharmacist and nurse practitioner researchers and educational/assessment experts. The use of the retrospective postsurvey then presurvey was intended to reduce response shift bias as a threat to internal validity (Rockwell & Kohn, 1989). Self-reporting is generally vulnerable to bias as learners may respond in the way that they believe their educator wants them to. Another limitation specific to the retrospective design of the survey was the potential inaccuracy of student recall when responding to the statements based on what their perceptions were prior to the activity. Finally, the study was limited by the small population included, especially in that the results may not be directly applicable to teaching and learning strategies for other professional students. Repeating the study with the use of a control group may more accurately demonstrate the impact of the intervention.

Future directions include evaluation of the duration and timing of the educational intervention in FNP student curricula, to optimize outcomes and also to identify the point at which incorporation of pharmacist-provided prescribing practice would be most meaningful, for example, in didactic versus experiential coursework. Broadening the application to prescriber training in other disciplines should also be explored.

Conclusions

Formative education on appropriate prescribing, including the opportunity for longitudinal practice, enhances preparedness of future nurse practitioner prescribers. Well-prepared prescribers would be expected to make fewer prescribing errors, leading to fewer preventable adverse drug events and reduction in delays initiating or optimizing drug therapy. Exposure of the nurse practitioner students to pharmacist expertise in this area during training may also encourage future collaboration in practice, which could further reduce errors and impact outcomes for patients.

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